CHAPTER 5

CANADA'S NUCLEAR FUEL WASTE MANAGEMENT PROGRAM: THE ENVIRONMENTAL ASSESSMENT OF THE DISPOSAL CONCEPT

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Abstract. Over the last 17 years under the Nuclear Fuel Waste Management Program, Atomic Energy of Canada Limited (AECL) has developed and assessed a concept to dispose of nuclear fuel waste from Canada's CANDU reactors in a vault excavated in plutonic rock of the Canadian Shield. Arobust concept has been developed, with options for the choice of materials and designs for the different engineered components of the disposal system. AECL submitted in 1994 October an Environmental Impact Statement on the Concept for the Disposal of Canada's Nuclear Fuel Waste for review under the Canadian Environmental Assessment and Review Process. If the review is completed in 1996, as currently expected, and if the concept is accepted by the review panel and approved by government, disposal would not likely begin before about 2025.

5.1 INTRODUCTION

About 20% of Canada's electricity is generated using CANDU nuclear reactors. Three provincial utilities, Ontario Hydro, Hydro-Quebec and New Brunswick Power, own these reactors and the used fuel removed from them. The used fuel is currently stored in water-filled pools or in dry-storage concrete storage structures. Current storage practices, while safe, require continuing institutional controls, such as security measures, monitoring and maintenance. Thus, storage is an effective interim measure for the protection of human health and the environment, but not a permanent measure. Disposal is needed to manage nuclear fuel waste in a way that does not depend on institutional controls to maintain safety in the long term.

Canada, like other countries, is basing its plans for disposal of nuclear fuel waste on deep geological disposal in the rock of a continental land mass. The Nuclear Fuel Waste Management Program (NFWMP) was launched in 1978 as a joint initiative by the governments of Canada and Ontario. Under the program, Atomic Energy of Canada Limited (AECL) has been developing and assessing a concept to dispose of nuclear fuel waste in plutonic rock of the Canadian Shield. Ontario Hydro has advanced the technologies for interim storage and transportation of used fuel. The two governments stated in 1981 that selection of a nuclear fuel waste disposal site would not proceed until the concept had been reviewed and assessed. Thus, a generic rather than a site-specific concept has been developed.

Participants in the program have included AECL, the lead agency for research on nuclear fuel waste disposal; Ontario Hydro, which has advanced the technologies for storage and transportation as well as contributing financially and technically to the R&D on disposal; Natural Resources Canada (NRCan); Environment Canada; scientists at Canadian universities; and consultants in the private sector. An independent Technical Advisory Committee has provided advice on the scope and quality of the technical work.

During the past seventeen years, AECL has carried out detailed studies on the multiple-barrier disposal concept. The objective has been to develop a concept with flexibility in the choice of methods, materials, and designs for the components of the disposal system. The approach has focused on ensuring that the system as a whole meets safety standards by a large margin.

5.2 THE DISPOSAL CONCEPT

The disposal concept being investigated is a proposed method for the geological disposal of nuclear fuel waste in which:

1. The waste form would either be used CANDU fuel or solidified highly radioactive reprocessing waste;

2. The waste form would be sealed in a container designed to last at least 500 years and possibly much longer;
3. The containers of waste would be placed in rooms in a disposal vault or in boreholes drilled from the rooms;
4. The vault would be nominally 500 to 1000 metres deep;
5. The geological medium would be plutonic rock of the Canadian Shield;
6. Each waste container would be surrounded by a buffer;
7. Each room would be sealed with backfill and other vault seals; and
8. All tunnels, shafts and exploration boreholes would ultimately be sealed so that the disposal facility would be passively safe, that is, so that long-term safety would not depend on institutional controls.

After the disposal vault is closed, a series of engineered and natural barriers would protect humans and the natural environment from the radioactive and chemically toxic contaminants in the nuclear fuel waste. These barriers include the waste form; the container; the buffer, backfill and other vault seals; and the geosphere (the rock, any sediments overlying the rock below the water table and the groundwater flow system). Institutional controls would not be required to maintain safety in the long term.

The nuclear fuel waste, or waste form, would be either used CANDU fuel or, if the used fuel was reprocessed in the future, the solidified highly radioactive waste from reprocessing. The low solubility of used CANDU fuel under the expected disposal conditions would make it effective for retaining radioactive and chemically toxic contaminants, thus it is an excellent waste form in its current state. The liquid radioactive waste that would result if used fuel were reprocessed would not be suitable for direct disposal, but such waste could be solidified to produce an excellent waste form.

The waste form would be sealed in a container to facilitate handling and to isolate it from groundwater for a desired minimum time. The container would be designed to have a minimum life of 500 years following emplacement in a disposal vault. As the conditions at potential sites may vary, the container geometry, material and fabrication method would be developed for each particular waste form and site. Important considerations in the design of containers would include the temperature and pressure that would be imposed on the container at the depth and location selected for the disposal vault and the chemical and microbial environment expected at each site.

The containers of nuclear fuel waste would be emplaced in a disposal vault excavated nominally 500 to 1000 metres below the surface in the plutonic rock of the Canadian Shield. The disposal vault would be a network of horizontal tunnels and disposal rooms that would be excavated deep in the rock, with vertical shafts extending from the surface to the tunnels. Rooms and tunnels might be excavated at more that one level. The vault would be designed to accommodate the rock structure and the subsurface conditions at the chosen site. The method of emplacing the containers in the vault would be selected to suit the specific characteristics of the site and container geometry. Figure 5.1 shows two possibilities for emplacing waste in a vault.

Within the multiple barrier system, the vault seals would perform the following functions to enhance the isolation of the nuclear fuel waste:

1. The buffer would inhibit the movement and modify the chemistry of the groundwater near each container to limit the container corrosion rate, the waste form dissolution rate, and the movement of contaminants;
2. The backfill would fill the space in disposal rooms to keep the buffer and containers securely in place, and in shafts and tunnels to reduce the potential for human intrusion. It would also retard the movement of contaminants by slowing the movement of groundwater, enhancing sorption of contaminants and by chemically conditioning the groundwater;
3. Bulkheads would inhibit groundwater movement at the entrance of disposal rooms, contain any pressures exerted by the backfill, and prevent easy human access to the emplaced waste;
4. Plugs and grouts, located at hydraulically critical locations in the disposal vault, such as locations where shafts and tunnels intersect fracture zones, would inhibit groundwater movement and the potential for contaminant transport in the excavations and in the rock around excavations; and
5. Shaft seals would prevent the shafts from being a preferential pathway for groundwater movement and would reduce the possibility of human intrusion into the sealed disposal vault.

The materials selected for vault seals need to have low hydraulic conductivity (in the order of 10^{-10} m/s or

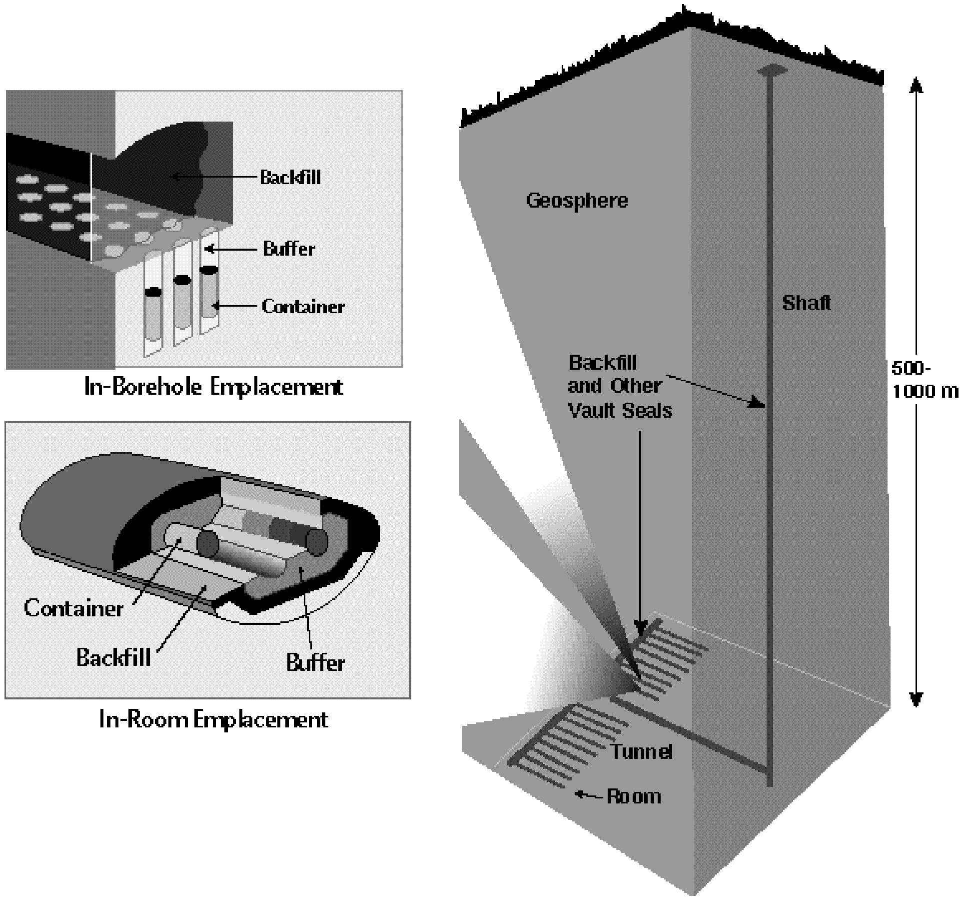

Figure 5.1. The disposal concept showing two examples of waste emplacement.

lower), must be available in the volumes required, must be workable and placeable with current technology, and must have predictable long-term performance.

The geosphere, comprising the plutonic rock, any sediments overlying the rock below the water table, and the groundwater flow system, would surround the disposal vault. The function of the geosphere, as a barrier, would be to protect the waste form, the container and the vault seals from natural disruptions and human intrusion; to maintain conditions in the vault favourable for long-term waste isolation; and to limit the rate at which contaminants from the waste could move from the vault to the biosphere. Any characteristics of a geological medium that support or enhance these functions would be considered favourable.

The plutonic rock bodies of the Canadian Shield are considered favourable as a disposal medium for Canada because they have many characteristics considered favourable including:

1. Wide geological distribution, allowing flexibility in siting, and wide distribution in regions of low topographic relief, where the driving force for groundwater movement in the rock is likely to be low;
2. Geological stability and the likelihood of remaining stable;
3. Very large size, in many cases, allowing the disposal rooms to be located away from discontinuities;
4. Fewer ore bodies associated with them than other types of rock bodies;
5. Relatively high thermal conductivity to dissipate the heat released from the emplaced waste;
6. Chemical composition and hydrogeological characteristics that favour retention and retardation of the type of contaminants expected in the waste form; and
7. Low frequency of permeable fractures, away from

the widely spaced fracture zones, below a depth of 200 to 500 metres.

The choice of methods, materials, and designs for an actual disposal system will ultimately be made on the basis of performance assessments taking into account the characteristics of the specific site on which the facility is to be developed, availability of materials, cost, and practicality. They could include, for example:

- the form of the waste: used fuel bundles or fuel reprocessing waste incorporated in a stable matrix, e.g. glass or ceramic;
- the disposal container material: titanium alloy, copper, or other durable material;
- the container design;
- the composition of materials used for the buffer, backfill, and other seals;
- the excavation method: blasting or boring;
- the depth, geometry, and the number of levels of the vault;
- the size and shape of the excavated openings; and
- the location of the waste containers: within disposal rooms or in boreholes drilled from the rooms.

These choices will not be made until a site for a vault has been selected.

5.3 ENVIRONMENTAL REVIEW

The federal Department of Energy, Mines and Resources (EMR) (now Natural Resources Canada, NRCan) referred the concept for review under the Environmental Assessment and Review Process (EARP) in 1988. As the "Proponent" for this review, AECL is responsible for preparing and submitting an Environmental Impact Statement (EIS) describing the concept. The Environmental Assessment Panel responsible for carrying out the review is chaired by Mr. Blair Seaborn. The Panel has appointed a Scientific Review Group (SRG), chaired by Professor Raymond Price and composed of eminent scientists from a variety of relevant disciplines, to assist it in judging the technical validity and acceptability of the disposal concept. The Canadian Environmental Assessment Agency (CEAA), formerly Federal Environmental Assessment Review Office (FEARO), provides administrative support to the Panel.

The Panel will review AECL's concept, along with a broad range of nuclear fuel waste management issues. These include the criteria for determining safety and acceptability; the approaches used in handling nuclear fuel waste both in Canada and other countries; the potential social, economic, and environmental effects of waste disposal; and the potential impact of recycling and other processes on waste volume. A general review of other aspects of the nuclear industry, such as energy policy and reactor operation and safety, is specifically excluded from the Panel's review.

All federal departments with a relevant interest in the concept are expected to participate in the review process. These include the Atomic Energy Control Board (AECB), NRCan, Environment Canada, Health and Welfare Canada, and Transport Canada. NRCan has assembled a team to review the results of AECL's R&D program, and Environment Canada has assembled two teams of experts to review in detail how well the concept protects the environment.

When the EARP review is concluded, the Panel will make recommendations as to the acceptability of the concept and the course of future action regarding nuclear fuel waste disposal. Government decisions will then follow.

In the spring of 1990, CEAA organized a series of "Open Houses" to inform interested parties, not directly connected with the nuclear industry or with the scientific review process, about how they could take part in the review. "Scoping Hearings" took place in the autumn of 1990 to identify issues of concern, and to assist the Panel in setting guidelines for the EIS. One hundred and thirty participants made presentations, including government departments, scientific and business organizations, special interest groups, and private individuals. Among the major issues raised were arguments for and against storage as compared with disposal, the adequacy of the regulatory criteria, and monitoring the performance of the disposal vault. Aboriginal land claims affect much of the land where a disposal vault could be sited. In view of this, an aboriginal representative was added to the Panel.

In June 1991 the Panel issued draft Environmental Impact Statement guidelines for comment. Over thirty different groups and individuals submitted comments. The Panel issued its final guidelines to AECL in March of 1992.

AECL responded to these guidelines by preparing and issuing the Environmental Impact Statement and nine primary reference documents to support the

Environmental Impact Statement. These documents provide a complete description of the concept and the technology that has been developed over the past 15 years. The EIS also provides additional information specifically requested by the Panel.

The nine primary references were issued in 1993 and 1994. The Environmental Impact Statement on the Concept for Disposal of Canada's Nuclear Fuel Waste, and the Summary of the Environmental Impact Statement on the Concept for Disposal of Canada's Nuclear Fuel Waste were completed and submitted to the EARP Panel in 1994 October. The Panel released these documents to the public and initiated a nine month review period for the public to assess their completeness and provide comments to the Panel. By 1995 January 31, AECL had distributed about 18,500 copies of these documents.

From 1994 November to 1995 March, CEAA conducted another series of Open Houses in 21 communities across the review provinces; New Brunswick, Quebec, Ontario, Manitoba and Saskatchewan. These were designed to familiarize the public with the review process, the disposal concept, and nuclear fuel waste transportation and storage and to encourage their participation in the review of the completeness of the EIS and in the Public Hearings announced for later. At many of the Open Houses, short formal presentations were made by CEAA, AECL and Ontario Hydro staff. These were often followed by a question period. About 2750 people attended the presentations or visited the AECL exhibit.

The environmental assessment panel released its approach for the public hearings in 1994 August. The approach is divided into three phases:

1. Phase I is designed to assist the panel addressing issues in the panel's terms of reference which go beyond the generic concept for deep geologic disposal including: the criteria by which safety and acceptibility of a concept for long-term management and disposal should be evaluated; the degree to which this generation should relieve future generations of the burden of caring for the waste; social, economic and environmental implications of a possible nuclear fuel waste management facility; the general criteria for site selection and a future site selection process; and the potential costs and benefits to potential host communities. This phase is scheduled for 1996 March and April in Toronto and other communities in Ontario.

2. Phase II of hearings will focus specifically on scientific and technical issues related to the safety of the AECL's generic concept for deep geologic disposal of nuclear fuel waste. This phase is scheduled for 1996 June in Toronto.

3. Phase III hearings will be held over six weeks in the autumn of 1996 in a number of communities in five provinces previously visited by the panel during the scoping phase of this review. This phase will involve presentations on: recommendations to assist governments in reaching decisions on the acceptability of the disposal concept; steps to be taken to ensure safe long-term management of nuclear fuel waste; criteria by which the safety and acceptability of a concept for long-term waste management and disposal should be evaluated; social, economic and environmental implications of a possible nuclear fuel waste management facility, including the impact of transportaion of nuclear fuel waste; general criteria for site selection and on a future site selection process; and the costs and benefits to potential host communities.

5.4 THE ENVIRONMENTAL IMPACT STATEMENT AND PRIMARY REFERENCES

The Environmental Impact Statement document provides an overview of AECL's case for the acceptability of the disposal concept, and provides information about the following topics:

- the characteristics of nuclear fuel waste;
- storage and the rationale for disposal;
- major issues in nuclear fuel waste management;
- the disposal concept and implementation activities;
- alternatives to the disposal concept;
- methods and results of the environmental assessments;
- principles and potential measures for managing environmental effects; and
- AECL's overall evaluation of the disposal concept.

The nine Primary References expand on particular socioeconomic and technical aspects AECL has evaluated in developing the concept:

Public Involvement and Social Aspects

- describes the activities undertaken to provide information to the public about the program and to obtain public input into the development of the disposal

concept;
- presents the issues raised by the public and how the issues have been addressed during the development of the disposal concept or how they could be addressed during the implementation of the disposal concept; and
- discusses social aspects of public perspectives on risk, ethical issues associated with nuclear fuel waste management, and principles for the development of a publicly acceptable site selection process.

Site Screening and Site Evaluation Technology

- discusses geoscience, environmental, and engineering factors that would need to be considered during a siting process; and
- describes the methodology for site characterization, that is, for obtaining the data about regions, areas, and sites that would be needed for facility design, monitoring, and environmental assessment.

Engineered Barriers Alternatives

- describes the characteristics of nuclear fuel waste;
- describes the materials that were evaluated for use in engineered barriers, such as containers and vault seals;
- describes potential designs for containers and vault seals; and
- describes procedures and processes that could be used in the production of containers and the emplacement of vault-sealing material.

Engineering for a Disposal Facility

- discusses alternative vault designs and general considerations for engineering a nuclear fuel waste disposal facility;
- describes a reference disposal facility design that was used to assess the technical feasibility, costs, and potential effects of disposal (The term “reference” is used to designate the disposal systems, including the facility designs, specified for the assessment studies. Different disposal facility designs are possible and might be favoured during concept implementation.); and
- presents cost and labour estimates for implementing the reference design.

PreclosureAssessment of a Conceptual System

- describes a methodology for estimating effects on human health, the natural environment, and the socioeconomic environment that could be associated with siting, constructing, operating (including transporting used fuel), decommissioning, and closing a disposal facility;
- describes an application of this assessment methodology to a reference disposal system;
- discusses technical and social factors that would need to be considered during siting; and
- discusses possible measures and approaches for managing environmental effects.

Postclosure Assessment of a Reference System

- describes a methodology for:
  - estimating the long-term effects of a disposal facility on human health and the natural environment,
  - determining how sensitive the estimated effects are to variations in site characteristics, design parameters, and other factors, and
  - evaluating design constraints; and
- describes an application of this assessment methodology to a reference disposal system.

The Vault Model for Postclosure Assessment

- describes the assumptions, data, and models used in the postclosure assessment to analyze processes within and near the buried containers of waste; and
- discusses the reliability of the data and models.

The Geosphere Model for Postclosure Assessment

- describes the assumptions, data, and models used in the postclosure assessment to analyze processes within the rock in which a disposal vault is excavated; and
- discusses the reliability of the data and models.

The Biosphere Model, BIOTRAC, for Postclosure Assessment

- describes the assumptions, data, and models used in the postclosure assessment to analyze processes in the near-surface and surface environment; and
- discusses the reliability of the data and models.

The EIS and the nine Primary References comprise some 6000 pages.

5.5 REASONS FOR CONFIDENCE IN THE DISPOSAL CONCEPT

Our confidence in the long-term safety of the concept draws strength from a number of sources:

1. The technical approach, the use of multiple barriers for redundancy and defence in depth;
2. The adoption of an observational approach to site characterization and to disposal vault design, construction, operation and eventually closure;
3. An approach to the project which is based on ongoing review and decision-making and which recognizes that, throughout, the process must be flexible and responsive and that decisions can be modified; and
4. Active and effective involvement of the public in the process.

5.6 THE MULTIBARRIER SYSTEM

In common with the approach adopted in other countries, the concept developed by AECLinvolves isolating the waste from the biosphere by a series of engineered and natural barriers. AECL's approach to development of the disposal concept has been to consider the performance of the system as a whole, rather than focusing on performance requirements for individual components. This approach allows flexibility in implementation to be retained and it increases the likelihood of identifying any counterintuitive interactions or synergisms among system components that could adversely affect safety. Thus, the performance of individual components, such as waste containers, is analyzed in the context of the system. This contrasts with a design and safety approach that prescribes performance standards for individual components and evaluates safety by the analysis of the performance of each component independently. Our goal, therefore, has been to develop a thorough scientific understanding of the performance of the different components of a disposal system and how these components interact and influence one another, so that the overall system can be designed to provide defence in depth.

Acquiring and building the necessary knowledge base is a continuing process, and in implementing disposal, flexibility must be retained so that new information and understanding acquired over time can be integrated into the disposal system. An example is container life-time. The original target was to achieve a minimum container life-time of 500 years and early work established that this goal could be achieved with a thin-walled titanium container. Subsequent studies on the corrosion of titanium and copper indicated that, for the expected groundwater chemistry, thin-walled titanium containers can be designed to have a corrosion lifetime in excess of tens of thousands of years, and a 25 mm thick copper container can potentially provide containment in excess of 10^6 years. Such advances in understanding and in our ability to defend, scientifically, this understanding can have a profound impact on the approach taken to facility design and implementation, and on decision-making.

Much of the evidence needed to evaluate any site that would be considered for deep geological disposal can be obtained from geologic information developed as the site is characterized, i.e., from the record of past changes preserved in the native rock mass and the groundwater. In the Canadian Shield the record available for investigation can be as long as two billion years.

Investigations at our field research areas, for example, indicate that discrete zones of intensely fractured rock, intersecting otherwise sparsely fractured rock, are the dominant pathways for groundwater flow at depths greater than 300 m to 500 m in plutonic rock of the Canadian Shield. The flux of groundwater can be high in the fracture zones; however, the flux is very low in the sparsely fractured rock bounded by the fracture zones, due to its very low permeability, which is commonly less than 10^{-18} m^2. Such low permeabilities can limit the rate of contaminant movement and indicate that within the overall disposal system, the host rock can play an important role as a natural barrier to the transport of radionuclides.

The field evidence is supplemented and complemented by understanding derived from laboratory studies, Field studies, including studies of natural analogues, can extend the short-term evidence from the laboratory studies to the longer times of interest - tens and even hundreds of thousands of years - and provide verification of the understanding incorporated in predictive modeling. For example, studies of the Cigar Lake uranium deposit in northern Saskatchewan have been under way since 1984. The uranium ore in the deposit has essentially the same composition as used fuel. It was formed some 1.3 billion years ago and has been in contact with groundwater since its deposition. Yet the uranium has remained stable under the reducing conditions prevailing in the deposit. Similar conditions are expected to occur in a disposal vault.

5.7 THE OBSERVATIONAL METHOD

No organization in Canada has yet been given the mandate to proceed with siting a disposal facility. Nevertheless, we can anticipate that the approach that will be used in site characterization and disposal vault

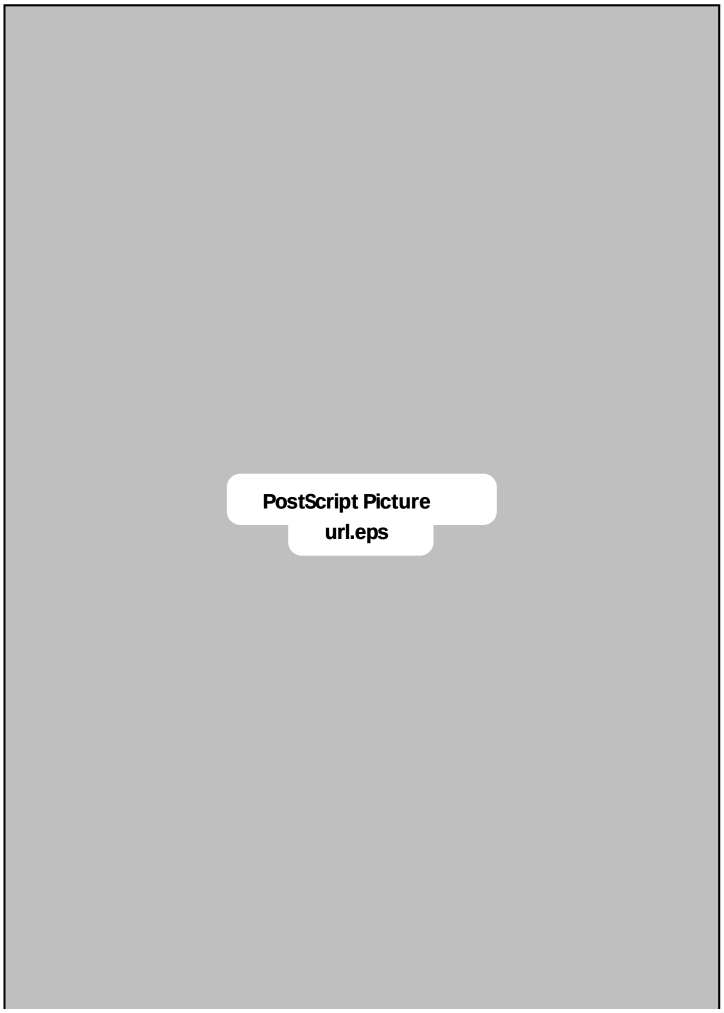

Figure 5.2. Underground research laboratory.

design, construction, operation, and eventually closure will be based on the observational method - the approach used in good geotechnical engineering. The observational method is a systematized approach to dealing with practical problems encountered when engineering in the sub-surface. In this approach, the results of modeling and computations during design are viewed as working hypotheses subject to confirmation or modification during construction. This approach provides a framework for decision-making in a situation where it is not practical, even if it were possible, to obtain all the detailed geotechnical information that would be needed for design of an underground facility prior to excavation at the site. As the project proceeds, the information is continuously acquired and incorporated into the design. A lack of detailed knowledge about local variability within a selected rock mass prior to excavation is common in underground construction. Nevertheless, major projects such as underground powerhouses and storage chambers, transportation tunnels, and dams are completed successfully using a design approach that accommodates observations made as construction is advanced. As part of its research program, AECL has constructed an Underground Research Laboratory for large-scale testing and *in-situ* engineering experiments on aspects of disposal (Figure 5.2). The observational method was used during the design and construction of this facility.

The observational method is also central to the use of performance assessment analyses as part of the design and implementation process. It is a continuously applied, iterative process. Beginning during the site selection phase, assessments are made based on all available data on the site conditions. The understanding of the site is incorporated into models for use in design and in performance assessment studies. Both the designs and the assessments become more refined as the knowledge of a site increases. Design and operational decisions are made on the basis of the understanding of site conditions at the time. The maximum possible flexibility is retained to incorporate technological improvements. In addition, the potential impacts of conceivable deviations from site conditions as understood need to be assessed and contingency measures established, in advance, to address the deviations should they be encountered.

As work proceeds, observation and evaluation of the actual conditions encountered are compared with the previous understanding and, if necessary, the detailed design and the models used in performance assessment are modified. This cycle continues throughout site selection, construction and operation, so that at each point when significant licensing and operational decisions need to be made, a long record of observation and a series of increasingly refined performance assessments are available on which to base the decision.

5.8 ONGOING REVIEW AND DECISION-MAKING

AECL views the current review as the beginning of a continuing process. As the technology for managing the disposal of nuclear fuel waste is developed and applied to specific sites, further reviews and public consultation and involvement will be needed. Any facility will be subject to rigorous regulatory criteria, and it is anticipated that society will demand that a step-by-step process be followed. Thus, a decision to proceed on the basis of the current review would represent only the first of a series of decisions between distinct phases of the process.

Each phase should lead to increased confidence in the overall system, thus facilitating decision-making about how and whether to proceed to the next phase. We are currently nearing the end of the first phase - concept development and assessment. If the Panel shares AECL's view that we have adequately developed the concept, and there is a governmental decision to proceed, the next appropriate step would be the start of site-specific activities, beginning with site screening. The sequence of events could be as follows:

1. Site screening would lead to the selection of one or more sites for detailed characterization based on surface techniques;
2. Such site characterization studies could lead to a selection of one or more sites for exploratory excavation and more extensive in-ground characterization;
3. In-ground characterization could lead to a decision to initiate construction and operation of a disposal vault, possibly beginning with a demonstration phase;
4. Design, construction and operation of a facility would involve ongoing review, reassessment and recommitment, leading to continued operation and then eventually to a decision to cease operations and decommission; and
5. Decommissioning and post-operational monitoring would ultimately lead to a decision to close and seal the vault.

The process of site screening and of evaluating several sites will likely involve a further ten to fifteen years of work before a commitment would be made to initiate an underground excavation, followed by a further ten years or so of site exploration and characterization before construction could begin. Thus, waste would not be emplaced in a vault before about 2025. By then we would have accumulated many years of site-specific data and a series of increasingly refined evaluations on which to base a decision to begin to emplace waste.

The decision to close and seal the vault would be made on the basis of the accumulated evidence and experience gained throughout the siting, characterization and operational phases, a process extending over close to a century. Only with that decision will disposal based on the concept have definitively been judged as safe and acceptable.

Thus, at the current concept assessment phase of the process, "concept approval" represents a judgment that:

- sufficient understanding has been developed to continue with the process, with an expectation that we will eventually reach the end point of sealing a vault; and that
- at the appropriate time, we should proceed to the next phase of the program, the beginning of site-specific activities to resolve outstanding issues that can only be resolved on a site-specific basis.

5.9 PUBLIC INVOLVEMENT

The general public and potential host communities are important constituencies which contribute to the decision-making when identifying options for waste management. Building public confidence in a program is therefore an important part of its development. The process to be followed in reviewing the program and deciding on future steps should involve consultation with, and the active participation of, the communities and public affected. Decision-makers need to have a mechanism to take public concerns into account when advancing major projects such as a disposal facility.

In Canada a formal mechanism for public involvement in the early part of project development is defined in environmental assessment and review legislation. The objective is to establish the scope of public concerns and interest early in the planning stage of a project so that steps can be taken to address the concerns in the project design. The public is asked to formally participate in the assessment and review and may be provided with the funds to do so.

In the Canadian program, no site will be selected for a disposal facility until the technology has first been evaluated in an environmental review. This review is currently under way. Because no directly affected community exists, public involvement at this stage is necessarily very broadly based. As part of concept development, AECL has carried out a public interaction program with the objectives of providing information to the general public and to those groups which have shown a particular interest in the program. At the same time we have endeavoured to identify the issues of concern to the public and to address these in the documentation describing the technology and our approach to disposal.

If the environmental review leads to a decision to proceed toward selecting a site, we anticipate that public involvement will continue and that it will become more community-specific. Beginning with siting, the organization selected to implement disposal, the implementing organization, would need to develop and maintain effective working relationships with potential host communities and with communities along potential transportation corridors. For these relationships to be effective, the implementing agency must demonstrate a commitment to principles of fairness, openness, shared decision-making, and above all to safety, so that affected communities can participate fully in the decision-making and so become empowered.

AECL proposes that the implementing organization adhere to the following principles:

Safety and Environmental Protection

In addition to complying with all applicable legislation, the implementing organization would keep adverse effects on human health, the natural environment, and the socioeconomic environment as low as reasonably achievable, taking social and economic factors into account.

Voluntarism

No community would be forced to host a disposal facility. A community would have the right to determine whether or not it was willing to be a host community.

Shared Decision Making

Implementation of the concept would occur in stages and would entail a series of decisions about whether and how to proceed. Each potential host community, and eventually the host community, would share in the decision making. In addition, the implementing organization would seek and address the views of other potentially effected communities.

Openness

Throughout the project, the implementing organization would offer information to the general public about its plans, procedures, activities, and progress. In addition, potentially affected communities would have access to all available information required to make a judgment about safety and environmental protection.

Fairness

In accepting a disposal facility, the host community would provide a significant service to the consumers of nuclear-generated electricity and to the public at large. In fairness, the net benefit to the host community should be correspondingly significant. The net benefit is not intended to induce a community to accept an unsafe disposal facility. As part of the negotiated program for managing environmental effects, measures would be taken to avoid, mitigate, or compensate for adverse effects; such measures would be enhanced or additional measures taken to ensure the betterment of the host community. Fairness also requires “due process,” which would be provided by adherence to the principles of voluntarism, shared decision making, and openness.

The principle of safety and environmental protection would not be compromised, no matter how acceptable or desirable a site might be in all other respects.

5.10 CONCLUSIONS AND RECOMMENDATIONS

AECL believes that it has developed a robust and flexible concept for disposal of nuclear fuel waste that will meet the regulatory requirements of Canada. In our EIS we conclude that:

1. Implementation of the disposal concept would protect human health and the natural environment from the potential adverse effects of nuclear fuel waste far into the future. In addition, human heath and the natural environment would be protected while the disposal concept was being implemented.
2. The disposal concept provides a means of minimizing the burden on future generations.
3. The disposal concept provides scope for public involvement during implementation.
4. Of the options that have been considered internationally, only geological disposal is a viable alternative for the disposal of Canada's nuclear fuel waste using currently available or readily achievable technology. The choice of plutonic rock of the Canadian Shield as the preferred disposal medium, made in the late 1970s, was appropriate, and plutonic rock should remain the preferred disposal medium for Canada.
5. The disposal technology does not rely on institutional controls as a necessary safety feature; it is adaptable to a wide range of physical conditions and to potential changes in criteria, guidelines and standards, and it includes monitoring and retrievability.
6. The methodology to evaluate safety of a disposal system against established safety criteria, guidelines, and standards has been developed and demonstrated to the extent reasonably achievable in a generic research program.
7. Technically suitable sites are likely to exist in Canada.

We are confident that implementation of our disposal concept represents a means by which Canada can safely disposal of its nuclear fuel waste.

We are continuing research and development work to ensure the public and the industry have as much confidence as possible in the safety of the concept and in the feasibility of implementing it.
The process for a federal environmental review of the concept is well under way. The review of a concept as opposed to a site- and design-specific project requires focusing on whether it is appropriate to proceed with the first phase of implementation. We believe that we have reached the stage in the NFWMP where the greatest benefit will result if activities proceed on a site-specific basis. Therefore, we have made the following recommendations in the EIS:

1. We recommend that the strategy for long-term management of Canada's nuclear fuel waste be based on the concept of disposal in plutonic rock of the Canadian Shield.
2. We recommend that those who have responsibility for the safe management of used fuel - the federal government and owners of the used fuel - also have responsibility for implementing the concept. In addition to addressing their requirements, the plan for implementation should address the requirements of any provincial government that could be affected by implementation, and those resulting from the present environmental review.
3. We recommend that those responsible for implementing the disposal concept be committed to the principles of safety and environmental protection, voluntarism, shared decision making, openness, and fairness.
4. We recommend that Canada progress toward disposal of its nuclear fuel waste by undertaking the first stage of concept implementation - siting.

We are in a very public process. Our experience has shown us that such processes are not easy for the nuclear industry. We believe that the information included in the EIS should lead the Panel to recommend that we proceed to the next phase of the process leading toward disposal. Our confidence is founded on the strength and depth of our technical program and on a well-founded public consultation program.